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AUTHOR Perkins, Kyle; Duncan, Ann
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ABSTRACT

To determine whether mastery of one reading comprehension task is a prerequisite to mastery of two or more reading comprehension tasks, a study examined the prerequisite relations existing in the item responses elicited from a sample of sixth grade students who took the Iowa Tests of Basic Skills, Form G, Level 12 reading comprehension test. Test items for 86 sixth graders enrolled in a small midwestern municipal school system were used for the study. To identify prerequisite relations (defined here as "a capability of prior learning which is incorporated into new learning"), item responses were submitted to an ordering-theoretic approach with a zero level tolerance for disconfirmatory response patterns. The identified prerequisite relations were submitted to a statistical test which used unit normal deviate approximation to determine whether the prerequisite relationships occurred by chance. Significant relationships were found to underlie the data, but no meaningful pattern in the results could be found when using the classes of skills objectives (i.e. facts, inferences, and generalizations) to explain the results. No meaningful pattern was found when analyzing data with Meyer's five rhetorical relationships; however, B. J. F. Meyer's three distinct levels of content structure proved helpful in explaining the results. Analysis indicated that by using ordering theoretic methods, reading teachers can determine what reading comprehension tasks comprise new learning and thus tailor the following year's instruction vis-a-vis prerequisite relations. One table is included. Appendixes consist of: reading comprehension tasks; table of notation for response patterns for two dichotomously scored items; and unit normal deviate approximation formula. (MM)

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Kyle Perkins
Southern Illinois University

and

Ann Duncan, Principal
Carterville (IL) Grade School

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The Determination of Prerequisite Relations in a Reading Comprehension Test

Abstract

Item responses from a standardized reading comprehension test were submitted to an ordering-theoretic procedure to determine the prerequisite relations which were present in the data set. The significant prerequisite relations were analyzed using a text structure approach. The development of reading comprehension skills and instructional design issues are discussed.

The purpose of the research reported herein was to identify the prerequisite relations which exist in the item responses elicited from a sample of sixth-graders who took the Iowa Tests of Basic Skills Form G, Level 12 reading comprehension test (Hieronymus, Hoover, and Lindquist, 1986a). The impetus for conducting this research was to determine whether mastery of one reading comprehension task is a prerequisite to mastery of two or more reading comprehension tasks, or conversely, whether mastery of two or more reading comprehension tasks is a prerequisite to one higher order reading comprehension task. In the context of this research we employ Gagne's (1977) definition of prerequisite: "a capability of prior learning which is incorporated into new learning. The previously learned entity actually enters into the newly learned capability, becomes and remains a part of the behavior which results from the events of learning" (p. 268).

The results of this research were intended to further inform the body of information concerning the growth and development of elementary school readers' comprehension tasks and processing and to further inform the investigation of the process of elementary school instruction. It

is a well-established tenet that ascertaining what the reader brings to the reading comprehension process is important. Gagne (1977), for example, emphasizes the essential nature of the learners' entering behavior as a crucial element to be considered in instructional design. Gagne notes that previously learned capabilities must be retrievable from long-term memory; must be readily accessible; may support new learning; and may be incorporated into new learning. Thus, the determination of prerequisite relations in a reading comprehension test may provide some insight into the development of reading skills in elementary school children and may prove beneficial in the instructional design of reading comprehension instruction.

This research employed ordering theory as the data analysis procedure (Airasian and Bart, 1975; Bart and Krus, 1973; Bart, Frey, and Baxter, 1979). Airasian and Bart (1975) define ordering theory as "an approach to fundamental measurement which has as its intent the definition of the best fitting linear or non-linear hierarchical network among a series of tasks....a deterministic measurement model which uses task response patterns to identify both linear and non-linear qualitative, prerequisite relations among tasks or behaviors" (p. 166). Ordering theory is a particularly useful tool for learning research because Gagne (1977) has reported that groups of tasks are likely to form branched, hierarchical, non-linear networks rather than hierarchical ^{linear} networks.

Bart and his colleagues consider task A to be a prerequisite to task B to the extent that the (01) response pattern does not occur, where 0 represents a "fail" on task A and 1 represents a "pass" on task B. In other words, the (01) response pattern is disconfirmatory to the extent that a correct response for task A is a prerequisite to a correct response

for task B. As Bart and Krus (1973) have noted, the (00), (10), and (11) response patterns are confirmatory, while the (01) response pattern is disconfirmatory for the defining statement specifying the prerequisite relationship: success on task A is a prerequisite to success on task B if and only if the response pattern (01) for tasks A and B respectively does not occur.

There are two parameters which the data must meet for an ordering-theoretic analysis. First, all tasks must be scored dichotomously, and second, all subjects in the sample must respond to all tasks. There is the further assumption that a correct response to a task reflects a manifestation of the latent trait being assessed.

Method

Subjects

The subjects for this study were 86 sixth-grade pupils enrolled in a small, midwestern, municipal school system. The method of selection was the natural assembly process. All students who sat for the examination were included in the sample save for those who did not respond to all of the items.

Instrumentation

The Iowa Tests of Basic Skills (Hieronymus, Hoover, and Lindquist, 1986a) is the standardized achievement battery which is used in the school's yearly assessment program. The Form G, Level 12 reading comprehension test contains 56 items.

Appendix A presents the tasks which are assessed and the number of items for each task.

(Put Appendix A about here)

Procedures

A contingency table for the 3,080 ($56 \times 56 - 56 = 3,080$) task/item pairs was constructed, and a zero tolerance level was established. In this context, zero tolerance means that if, for any task pair generically labelled AB, a single occurrence of an (01) response pattern was found, the prerequisite relationship ^{that} of success on task A is necessary for success on task B was ^{for} disconfirmed _A that particular task/item pair.

Once all the prerequisite relations were identified, they were submitted to a statistical test developed by Bart and Read (1984) to determine whether the prerequisite relationships occurred by chance. Bart and Read (1984) noted that the ordering-theoretic analysis is insensitive to item difficulty and that "if item i is an extremely easy item and item j is an extremely difficult item, the_A intuitively one would expect that most respondents would get item i correct and item j incorrect. This pairing of item difficulties could lead to an inflated occurrence of allowable response patterns (00, 10, and 11) and a deflated occurrence of the disallowable response pattern (01), producing the finding of a prerequisite relationship, when in fact no relationship existed" (p. 224).

Bart and Read's (1984) statistical test uses the table of notation for response patterns (Appendix B) and the Fisher's exact test's unit normal deviate approximation, the formula for which is found in Appendix C. The unit normal deviate approximation is in reality a z value, and the criterion

level for significance was set in advance at the .01 level. In other words, the test statistic produced by the formula in Appendix C for each prerequisite relationship had to equal or exceed 2.33 in order to be considered significant.

(Put Appendices B and C about here)

Meyer's (1975) prose analysis system was utilized as the framework for describing the significant prerequisite relationships found to underlie the reading comprehension item responses. Meyer's (1975) system was chosen because of its previous successful applications in investigations of the effects of text structure on the recall of prose materials and in behavioral anchoring analyses (Perkins and Brutton, 1988).

Meyer's (1975) system employs a "content structure" which relates all of a text's information and shows how some textual ideas are super-ordinate to other ideas. There are three distinct levels of content structure. The top-level structure consists of the rhetorical relationship that binds together all the propositions in a text and gives the text texture, or overall organization. This level also contains the main ideas, the gist, the text's message, which are called macropropositions. The middle third of the total content structure contains the major supporting details that complement the major premises of the text's message; these are called micropropositions. The bottom third contains very specific, minor details.

The purpose of the rhetorical relationships, according to Meyer (1984), is to "interrelate sentences, subordinate certain propositions to other propositions, and give a text its top-level structure" (p. 114). These rhetorical relationships fall into five basic groups:

- a. An antecedent/consequent or covariance rhetorical relationship shows a causal relationship between topics.
- b. A response rhetorical relationship includes the remark and reply, question and answer, and problem and solution formats.
- c. A comparison relationship points out differences and similarities between two or more topics.
- d. A collection relationship shows how ideas or events are related together into a group on the basis of some commonality.
- e. A description relationship gives more information about a topic by presenting attributes, specifics, explanations, or settings (Meyer and Rice, 1984, pp. 326-327).

Results

Prerequisite relations were found to exist between 45 of the 3,080 item/task pairs, 14 of which were significant at the .01 level. Table 1 presents the significant linear and branched prerequisite relationships which were found to underlie the item responses. The information shown at each node is presented in the following order: the tasks or skills objectives according to Hieronymus, Hoover, and Lindquist (1986b); the rhetorical relationship manifested in the reading passage on which the question was based (antecedent/consequent, response, comparison, collection, or description); and the distinct level of content structure of the reading passage on which the question was based (macroproposition, microproposition, or very specific detail), according to Meyer's (1975) prose analysis system.

(Put Table 1 about here)

Discussion

One would have expected that many, if not most, of the B tasks in the A $\longrightarrow$ B definition statement would have been generalization

tasks because generalizations "involve higher order skills concerned with organization, application, purpose, and viewpoint of the author, and the structure, mood, or style of the selection" (Hieronymus, Hoover, and Lindquist, 1986b, p. 45). However, generally that was not the case. Only in prerequisite relationship 2 does one see multiple cases of this phenomenon. What one does note in terms of a trend or generalization from an inspection of the prerequisite relationships is that the A tasks are typically tasks which are nested in the top levels of a Meyer content structure and the B tasks are tasks which are nested in the bottom levels of a Meyer content structure. The exception to this trend is prerequisite relationship 4 which has to do with the interpretation and explication of words, figurative language, and the author's voice. It is apparant from prerequisite relationship 4 that the ability to interpret figurative language and to deduce the meanings of words is a necessary prerequisite to inferring and to explicating style and the traits of characters.

As was stated in the previous paragraph, a general thesis statement which can be inferred from the results of this research is that, in the main, success with reading comprehension tasks which have to do with Meyer top-level structures, i.e., macropropositions and micropropositions, is a prerequisite for success with reading comprehension tasks which have to do with Meyer mid- and bottom-level structures, i.e., micropropositions and very specific details. This finding complements six basic research findings that have emerged from the Meyer system:

First, ideas which are located at the top levels of a structural analysis of prose are recalled and retained better than ideas which are located at the lower levels...Second, different items of information located high in the structure are more likely to be integrated in memory than items located low in the structure...

Third, the type and structure of relationships among ideas in prose dramatically influence recall when they occur at the top levels of the structure; however, when the same relationships occur low in the structure, they have little effect on recall. ... Fourth, different types of relationships at the top levels of the structure differentially affect memory....Fifth, students who are able to identify and use these top-level structures in prose remember more from their reading than those who do not...Sixth, training in how to recognize and use these top-level structures improves recall from text materials (Meyer and Rice, 1984, p. 329).

Summary

To summarize the major ~~points~~^{issues} of this research, we will make the following points. First, we sought to discover^v what, if any, prerequisite relations exist in the item responses from a standardized reading comprehension test which was administered to the sixth-grade cohort in a small midwestern school. Second, to identify the prerequisite relations, we submitted the data to the Bart-Krus ordering-theoretic approach with a zero level tolerance for disconfirmatory response patterns. Third, the identified prerequisite relations were submitted to a statistical test which utilized unit normal deviate approximation to determine whether the prerequisite relationships occurred by chance. Fourth, 14 significant relationships were found to underlie the data. Fifth, no meaningful pattern in the results could be found when we tried to use the classes of skills objectives, i.e., facts, inferences, and generalizations, to explain the results. Sixth, no meaningful pattern in the results could be found when we tried to use Meyer's five rhetorical relationships to explain the results; however, Meyer's three distinct levels of content structure proved to be quite helpful in explaining the results.

In the context of Gagne's (1977) research, we can report that for this sample of sixth-grade readers there is evidence that they have mastered

the reading tasks whose loci are in the Meyer top-level structures, but they need further instruction on reading tasks whose loci are in the Meyer bottom-level structures. By using ordering-theoretic methods reading teachers can determine what reading comprehension tasks comprise new learning and thus can tailor the following year's reading comprehension instruction vis-a-vis prerequisite relations, thereby fitting the reading comprehension curriculum to the student instead of fitting the student to the reading comprehension curriculum.

References

- Airasian, P. W., & Bart, W. M. (1975). Validating a priori instructional hierarchies. Journal of Educational Measurement, 12, 163-173.
- Bart, W. M., & Krus, D. J. (1973). An ordering-theoretic method to determine hierarchies among items. Educational and Psychological Measurement, 33, 291-300.
- Bart, W. M., Frey, S., & Baxter, J. (1979). Generalizability of the ordering among five formal reasoning tasks by an ordering-theoretic method. Child Study Journal, 9, 251-259.
- Bart, W. M., & Read, S. A. (1984). A statistical test for prerequisite relations. Educational and Psychological Measurement, 44, 223-227.
- Brownlee, K. (1965). Statistical theory and methodology in science and engineering. New York: Wiley.
- Gagne, R. M. (1977). The conditions of learning (third edition). New York: Holt, Rinehart and Winston.
- Hieronimus, A. N., Hoover, H. D., & Lindquist, E. F. (1986a). Iowa tests of basic skills, Form G, Level 12. Chicago: The Riverside Publishing Company.

Hieronymus, A. N., Hoover, H. D., & Lindquist, E. F. (1986b). Preliminary teacher's guide. Multilevel battery. Levels 9-14. Chicago: The Riverside Publishing Company.

Meyer, B. J. F. (1975). The organization of prose and its effect on memory. Amsterdam: North-Holland Publishing.

Meyer, B. J. F. (1984). Organizational aspects of text: Effects on reading comprehension and applications for the classroom. In J. Flood (Ed.), Promoting reading comprehension (pp. 113-137). Newark, DE: International Reading Association.

Meyer, B. J. F., & Rice, G. E. (1984). The structure of text. In P. D. Pearson (Ed.), Handbook of reading research (pp. 319-351). New York: Longman.

Perkins, K., & Bratten, S. R. (1988). A behavioral anchoring analysis of three ESL reading comprehension tests. TESOL Quarterly, 22, 607-622.

Appendix A
Reading Comprehension Tasks

<u>Skills Objectives</u>	<u>Number of Items</u>
F Facts: To Recognize and Understand Stated Factual Details and Relationships (Literal Meaning)	17
F1 Description: To understand factual details relating to description of people, places, objects, and events	5
F2 Categorization: To understand factual details relating to classification	1
F3 Relationships: To understand functional relationships, time, and sequence	6
F4 Contextual Meaning: To deduce the meanings of words or phrases from context	5
I Inferences: To Infer Underlying Relationships (Interpretative Meaning)	17
I1 Cause and Effect: To understand cause, effect, concomitance, and interaction	6
I2 Draw Conclusions: To draw conclusions from information and relationships	5
I3 Traits and Feelings: To infer traits, feelings, and emotions of characters	3
I4 Motives: To infer the motives and reasons for the actions of characters	3
G Generalizations: To Develop Generalizations from a Selection (Evaluative Meaning)	22
G1 Main Idea: To recognize the main idea or topics of a paragraph or selection	6
G2 Organization: To understand the organization of a paragraph or selection	2
G3 Application: To apply information through generalization or prediction	1
G4 Purpose: To recognize the author's purpose, motive, or intention	4

G5 Viewpoint: To recognize the author's viewpoint, attitude, or bias	1
G6 Figurative Language: To interpret figurative language	2
G7 Mood: To recognize mood or tone of a selection	2
G8 Style: To recognize qualities of style or structure	4
Total	56

(Hieronymus, Hoover, and Lindquist, 1986b, p. 45)

Appendix B
Table of Notation for Response Patterns for Two Dichotomously Scored Items,
A and B

		Item B		
		1	0	
Item A	1	n_{11}	n_{12}	$n_{1.}$
	0	n_{21}	n_{22}	$n_{2.}$
		$n_{.1}$	$n_{.2}$	

(Bart and Read, 1984, p. 225)

Appendix C
Unit Normal Deviate Approximation

$$u = \frac{n_{11} - \frac{n_{1.}n_{.1}}{n}}{\left(\frac{n_{1.}n_{2.}n_{.1}n_{.2}}{n^3} \right)^{1/2}}$$

(Brownlee, 1965, p. 165)

Table 1
Significant Prerequisite Relations

Prerequisite relationship 1

Inference: to draw conclusions from information and relationships; antecedent/consequent; very specific detail.



Fact: to deduce the meanings of words or phrases from context; description; macroproposition.

Prerequisite relationship 2

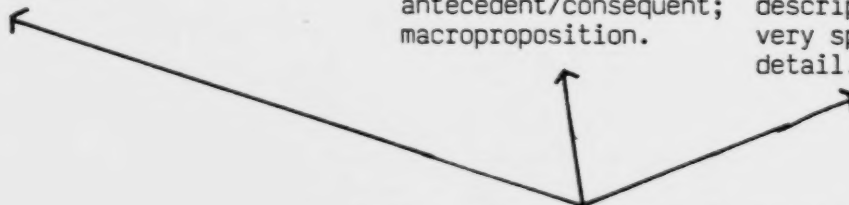
Fact: to understand factual details relating to description of people, places, objects, and events; antecedent/consequent; very specific detail.

Inference: to infer the motives and reasons for the actions of characters; antecedent/consequent; very specific detail.

Generalization: to interpret figurative language; antecedent/consequent; macroproposition.

Inference: to infer the motives and reasons for the actions of characters; antecedent/consequent; macroproposition.

Generalization: to recognize qualities of style or structure; description; very specific detail.



Inference : to infer the motives and reasons for the actions of characters; antecedent/consequent; microproposition.

Prerequisite relationship 3

Inference: to infer traits, feelings, and emotions of characters; antecedent/consequent; very specific detail.

Fact: to deduce the meanings of words or phrases from context; antecedent/consequent; very specific detail.

Fact: to understand functional relationships, time, and sequence; antecedent/consequent; very specific detail.

Fact: to understand factual relating to classification; antecedent/consequent; very specific detail.



Inference: to understand cause, effect, concomitance, and interaction; antecedent/consequent; macroproposition.

Prerequisite relationship 4

Inference: to infer traits, feelings, and emotions of characters; antecedent/consequent; microproposition.

Inference: to draw conclusions from information and relationships; antecedent/consequent; very specific detail.

Generalization: to recognize qualities of style or structure; antecedent/consequent; very specific detail.

Fact: to deduce the meanings of words or phrases from context; antecedent/consequent; very specific detail.

Generalization: to interpret figurative language; description; very specific detail.